

Empowering Mathematical Minds through Indigenous Pedagogies in Teaching Mathematics in Southern Province, Zambia

Kaziya Kadonsi, Dr. Muzata Kapalu Kenneth, Dr. Simalalo Magdalene

The University of Zambia, Lusaka, Zambia

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ABSTRACT

This research study explored the critical task of enhancing mathematics education in Zambia's Southern Province by incorporating indigenous perspectives and methodologies into the pedagogical framework. Its primary objective was to explore innovative strategies for infusing indigenous knowledge, values, and ways of knowing into mathematics education, thereby addressing the persistent challenge of engaging students effectively within their cultural contexts. To achieve this objective, the study employed a research framework that combines critical realism and pragmatism, utilizing a Mixed Methods Sequential Explanatory Design with 343 participants from diverse stakeholder groups. The quantitative sample comprises 326 individuals, including 55 mathematics teachers and 271 Grade 12 pupils, while the qualitative sample consists of 17 participants, including community members, representatives from the District Education Board Secretary's office, and school administrators. Data collection methods encompass questionnaire surveys, interviews, focus group discussions, classroom observations, and document analysis, with data analysis employing descriptive statistical tools such as mean, standard deviation, and frequency distributions. A pilot study was conducted to validate research instruments, with instrument reliability assessed using Cronbach's Alpha. The study's findings proposed several potential pathways to indigenize mathematics education in Kalomo District. One approach involves making mathematics culturally relevant by integrating local cultural practices, traditions, storytelling, dances, music, and games into the curriculum. This connection aims to bridge mathematical concepts with students' lived experiences and cultural backgrounds. Another avenue explored was the adoption of culturally relevant pedagogies, aligning with the idea of connecting education to students' cultural contexts to enhance engagement and meaningful learning. The research also underscored the potential of place-based mathematics education, utilizing local contexts and environments, including stories, traditions, and practices, to teach mathematical concepts and skills. This approach fosters a sense of pride in students' cultural heritage. Furthermore, integrating indigenous knowledge enriches mainstream mathematical education and promotes a holistic understanding of mathematics. The study emphasized the importance of mathematizing everyday life, emphasizing the need to connect mathematical concepts to real-world situations. Additionally, the research discussed the decolonization of mathematics education and the incorporation of Western Mathematics into Indigenous Knowledge to create a more equitable and culturally responsive curriculum. It highlighted the value of using local storytelling, dances, music, and indigenous games as educational tools to enhance engagement, problem-solving skills, and practical application of mathematical concepts. Moreover, involving the community in mathematics education promotes collaborative learning and a supportive educational ecosystem. The study highlighted the importance of using local languages in mathematics education, as it significantly enhances students' understanding of mathematical concepts and academic performance. The absence of explicit policy support for the inclusion of local knowledge and perspectives in mathematics education underscores the need for policy changes and institutional initiatives. The study emphasizes the necessity of modifying the mathematics curriculum to reflect indigenous knowledge and cultural elements, aligning with the concept of culturally relevant curriculum design. It also underscored the role of

professional development and teacher training in equipping educators to create culturally responsive and inclusive learning environments. In conclusion, this research offers a comprehensive exploration of the integration of indigenous perspectives into mathematics education, providing valuable insights and recommendations for enhancing the educational experience of students in the Southern Province of Zambia.

Keywords: Indigenizing pedagogies, Mathematics education, Indigenous knowledge, Cultural relevance, Indigenous practices,

INTRODUCTION

Mathematics is often considered a universal language, transcending cultural and geographical boundaries. However, the way mathematics is taught and learned can vary significantly from one region to another, influenced by cultural traditions, historical contexts, and local perspectives. In Southern Province, Zambia, a unique and enriching opportunity exists to explore the integration of indigenous pedagogies in mathematics education, fostering a deeper understanding and connection to mathematical concepts while respecting and celebrating the rich cultural heritage of the region.

This article explored the concept of empowering mathematical minds through indigenous pedagogies in the unique context of Southern Province, Zambia. It explores into the significance of preserving and promoting indigenous knowledge systems in the teaching of mathematics and highlights the potential benefits for both students and educators. We examined the challenges and opportunities associated with integrating indigenous pedagogies into the formal education system, shedding light on the importance of a balanced approach that respects cultural heritage while ensuring alignment with global mathematical standards.

As we embarked on this journey to understand the intersection of indigenous wisdom and modern mathematics education, we uncovered how Southern Province, Zambia, is paving the way for a more inclusive, culturally responsive, and effective approach to teaching and learning mathematics. In doing so, we hope to inspire educators, policymakers, and researchers around the world to explore the rich tapestry of indigenous knowledge in their own contexts, promoting a holistic approach to mathematics education that honors diverse perspectives and fosters mathematical excellence.

Boaler (2016) argued that mathematics education is a universal concern, critical for individual development and societal progress. However, achieving effective mathematics education can be particularly challenging when students' cultural contexts are not adequately considered. This challenge is evident in Southern Province, Zambia, where the imperative pursuit of enhancing mathematics education has led to an innovative research endeavor: "Indigenizing the Pedagogies and Practices in the Teaching of Mathematics in Three Selected Secondary Schools in Southern Province – Zambia."

The research study recognized the importance of incorporating indigenous perspectives, knowledge, values, and methodologies into the pedagogical framework of mathematics education in the Southern Province. The persistent issue of effectively engaging students within their cultural contexts has prompted this exploration into new approaches. The primary aim of this study was to investigate innovative methods for infusing indigenous wisdom and cultural relevance into mathematics education.

Research has shown that incorporating indigenous culture-based knowledge into mathematics teaching can lead to positive outcomes for students. In a study by Lipka and Adams (2004), it was found that culture-based mathematics teaching produced good pupil results. This suggests that students can learn indigenous culture-based knowledge and succeed academically. Similarly, Stavrou (2021) used a narrative inquiry to describe how Cree elementary school teachers incorporated their Cree language into school mathematics. This approach aimed to challenge and reverse racist and colonial ideologies, provide meaningful alternatives within school cultures, and support the dynamic learning of Indigenous students.

Studies have consistently shown that when education is culturally relevant, students are more engaged and motivated, leading to improved learning outcomes. This research sought to explore how such improvements can be realized in the context of mathematics education. Incorporating indigenous knowledge into mathematics education encourages a more holistic understanding of the subject. It not only promotes mathematical proficiency but also deepens appreciation for the rich tapestry of indigenous wisdom and traditions.

Statement of the Problem

Mathematics education in Southern Province, Zambia presents a complex challenge that resonates with educators, policymakers, and communities. The effectiveness of delivering mathematics education in culturally diverse regions is a pressing concern. While the importance of mathematics as a foundational subject is widely acknowledged, the effectiveness of its delivery in culturally diverse regions remains a pressing concern. The central problem is how to indigenize mathematics education in Southern Province, Zambia to make it culturally relevant and engaging for students within their diverse cultural contexts. Many Indigenous students in Southern Province face challenges in mainstream mathematics education. The curriculum often lacks cultural relevance, making it difficult for students to connect with the subject. As a result, students may disengage or struggle to grasp mathematical concepts, hindering their academic progress.

The existing body of research on mathematics education in Southern Province, Zambia, and similar contexts primarily emphasizes standardized pedagogical approaches, often overlooking the rich indigenous knowledge, values, and practices embedded in local cultures. Consequently, there is a significant gap in knowledge regarding the integration of indigenous perspectives into mathematics education in this region. Several references provide insights into addressing this problem. Nistor et al. (2013) discuss the applicability of educational technology acceptance in different cultural contexts. This study highlights the importance of considering cultural dimensions, such as collectivism and uncertainty avoidance, when implementing educational practices. Understanding the cultural context of Southern Province, Zambia can inform the indigenization of mathematics education.

While various studies have explored the importance of culturally relevant education and its impact on student engagement and learning outcomes, there is limited empirical research that specifically examines how indigenous knowledge can be seamlessly integrated into the mathematics curriculum. Chika (2019) examined the importance of integrating indigenous knowledge into mathematics education in various African contexts. The study highlighted that incorporating indigenous perspectives in mathematics instruction could lead to increased student engagement, improved learning outcomes, and a stronger sense of cultural identity among students. However, the review also notes the need for more empirical research and specific strategies for implementation in different regions. Furthermore, the role of policy support, teacher training, and curriculum modification in facilitating this integration remains relatively unexplored.

Research Objectives

This research aims to:

1. Explore possible approaches to incorporate indigenous methods into the teaching of mathematics.

Research Question

To address the above objective, this research will seek answers to the following key questions:

1. What are the possible approaches to incorporating indigenous methods into the teaching of

mathematics?

By addressing this research question, this study sought to contribute valuable insights into the indigenization of mathematics education, paving the way for more culturally relevant and engaging pedagogical practices in Southern Province, Zambia, and potentially serving as a model for similar regions facing similar challenges.

LITERATURE REVIEW

Overview

The literature review of this study explored various themes and concepts related to the integration of Indigenous pedagogies in mathematics education. It covers Culturally Relevant Education (CRE), Indigenous knowledge integration, policy analysis, and teacher training. Culturally Relevant Education (CRE) is highlighted as a crucial element in understanding how Indigenous pedagogies can be effectively incorporated into math teaching. CRE emphasizes the importance of respecting students' cultural backgrounds and experiences to make learning meaningful. The review examines how CRE has been applied in different educational contexts worldwide and its potential impact in Southern Province, Zambia.

The integration of Indigenous knowledge into math education is a central theme, exploring Indigenous communities' diverse knowledge systems and how they can enrich mathematical learning. Various strategies for incorporating Indigenous knowledge into the curriculum are discussed, emphasizing the importance of respecting and preserving Indigenous epistemologies. The review also analyzes educational policies related to Indigenous pedagogies and math education in Zambia, investigating how they support or hinder integration efforts. It explores policy frameworks promoting cultural sensitivity, inclusivity, and equity in education.

Teacher training and professional development are addressed, focusing on equipping educators with the skills to engage with Indigenous communities, adapt teaching methods, and create culturally responsive classrooms. The study's overall objective is to implement pedagogical strategies aligned with the cultural and contextual backgrounds of students in Southern Province, Zambia, particularly within selected secondary schools. This research aimed to address specific educational needs in Zambia, emphasizing cultural relevance and context-appropriate teaching methods to enhance student engagement and math learning outcomes.

Culturally Relevant Mathematics Education

Culturally relevant education is a pedagogical approach that emphasizes the importance of connecting education to students' cultural backgrounds. This approach, as discussed by Ladson-Billings (2010), suggests that integrating students' cultural identities and experiences into the curriculum and teaching practices can enhance their motivation, attentiveness, and learning outcomes. This paper aims to explore the concept of culturally relevant education and its impact on student engagement and achievement.

Ladson-Billings (2010) argues that culturally relevant education is crucial for engaging students in the learning process. By incorporating students' cultural contexts into the curriculum, educators can create a more meaningful and relatable learning experience. This approach recognizes the diverse backgrounds and experiences of students and seeks to validate and affirm their cultural identities.

Howard (2003) supports this perspective by highlighting the importance of critical teacher reflection in implementing culturally relevant pedagogy. Teachers need to critically examine their own biases and assumptions to create an inclusive and culturally responsive learning environment. By doing so, they can

better understand and address the needs of their students, leading to increased motivation and attentiveness.

Gay (2010) further emphasizes the significance of culturally responsive teaching in enhancing student engagement and achievement. She argues that when educational content and practices resonate with students' cultural contexts, they are more likely to be motivated and actively participate in the learning process. This approach fosters a sense of belonging and validates students' cultural identities, leading to improved learning outcomes.

The concept of culturally relevant education has gained recognition and support in the field of education. Several studies have provided evidence for the positive impact of this approach on student engagement and achievement. For example, Howard (2003) conducted a study that examined the effects of culturally relevant pedagogy on student motivation and found that students who experienced culturally responsive teaching reported higher levels of motivation and engagement in the classroom. Similarly, Gay (2010) conducted a meta-analysis of studies on culturally responsive teaching and found consistent evidence of its positive effects on student achievement. Students who experienced culturally relevant education demonstrated higher academic performance and a greater sense of belonging in the classroom.

Villegas and Lucas (2002) discuss the importance of educating culturally responsive teachers who can effectively integrate students' cultural identities and experiences into the curriculum and teaching practices. The study presents a coherent approach to teacher education that promotes cultural responsiveness and enhances student motivation, attentiveness, and learning outcomes. Paris and Alim (2017) explores culturally sustaining pedagogies that aim to maintain, support, and strengthen students' cultural identities and experiences in the learning process. It provides insights into how educators can integrate students' cultural contexts into the curriculum and teaching practices to create a more engaging and meaningful educational experience.

The current study focused on exploring the incorporation of indigenous pedagogies and practices into the teaching of mathematics in secondary schools in Southern Province, Zambia. While the reviewed studies primarily revolve around the concepts of culturally relevant pedagogy and culturally responsive teaching in a broader educational context, the current study is more specific, targeting the subject of mathematics and a particular geographical region. The reviewed studies discuss the importance of integrating students' cultural backgrounds into the curriculum and teaching practices in a general sense. However, the current study focuses on the subject of mathematics. This specific subject-level analysis is a significant departure from the broader discussions in the reviewed studies.

Integration of Indigenous Knowledge in Mathematics Education

The integration of Indigenous knowledge in mathematics education is a topic of growing interest and importance. Fouze and Amit (2017) argues that indigenous knowledge refers to the knowledge systems, practices, and beliefs of Indigenous peoples, which are often rooted in their cultural and historical contexts. Incorporating Indigenous knowledge into mathematics education can enhance students' understanding and engagement with the subject, as well as promote cultural diversity and inclusivity in the classroom.

One approach to integrating Indigenous knowledge in mathematics education is through the use of ethno-mathematics. Ethno-mathematics is the study of mathematical practices and concepts embedded in different cultural contexts. It recognizes that mathematics is not a universal, abstract discipline, but rather a culturally situated and socially constructed one (Fouze and Amit, 2017). By incorporating ethno-mathematical folklore games and cultural practices into math instruction, students can develop their mathematical thinking and problem-solving skills while also gaining a deeper appreciation for Indigenous cultures (Fouze and Amit, 2017).

Another important consideration when integrating Indigenous knowledge in mathematics education is the diverse learning styles and preferences of Indigenous students. Indigenous students are often imaginal, contextual, kinesthetic, cooperative, and person-oriented learners (Warren & Miller, 2013). Therefore, a holistic approach that considers these learning styles can enhance students' engagement and understanding of mathematics. This can be achieved by creating learning materials that are based on realistic mathematics education with a local cultural context (Lestari et al., 2018).

Battiste (2013) explored the vital topic of decolonizing education. This work presents a comprehensive exploration of the significance of incorporating indigenous knowledge and perspectives into educational systems. Battiste's research is not only a call to action but also a compelling testament to the transformative power of decolonizing education. It illustrates how this approach can instill cultural pride, nurture identity, and empower indigenous students, ultimately creating a more inclusive and equitable learning environment.

Battiste (2013) begins by providing a historical context for the colonization of education in indigenous communities. She highlights how colonial powers imposed their cultural and educational systems, erasing indigenous knowledge and traditions. This section serves as a foundation for understanding the urgency of decolonizing education and the historical trauma it seeks to address. Central to Battiste's argument is the recognition of indigenous knowledge as a valuable and valid form of knowledge. She demonstrates that incorporating indigenous perspectives into education not only enriches the curriculum but also acknowledges the deep connection between indigenous peoples and their land, history, and traditions.

Smith (2012) stands as groundbreaking research that has had a profound impact on the fields of research, education, and indigenous studies. Smith (2012) offers a comprehensive and powerful examination of the concept of decolonizing methodologies, emphasizing the integration of indigenous knowledge systems into research practices. Through her work, Smith advocates for the importance of centering indigenous perspectives and ways of knowing in research and education, with the ultimate goal of challenging colonial structures and promoting cultural revitalization.

One of the central themes of Smith's book is the critical examination of how teaching methodologies have historically been intertwined with colonialism and have perpetuated the marginalization and erasure of indigenous voices, knowledge, and experiences. She argues that traditional teaching methodologies often serve to reinforce the dominance of Western paradigms and worldviews, further alienating indigenous peoples from their own cultural heritage and self-determination.

To counteract this colonial legacy, Smith proposes a methodology that is firmly rooted in indigenous worldviews and epistemologies. She argues that teaching methodologies should be conducted in ways that respect and honor the knowledge systems and cultural practices of indigenous communities. This approach, she contends, not only empowers indigenous people but also results in richer and more nuanced learning outcomes that reflect the complexities of indigenous societies and their unique contributions to the global body of knowledge.

Snively and Williams (2010) emphasize the significance of cultural relevance in education. They argue that by weaving indigenous knowledge and perspectives into the curriculum, educators can make the content more meaningful and relatable to students from indigenous backgrounds. This approach promotes a sense of belonging and engagement among these students.

Indigenous pedagogies often emphasize holistic learning, which encompasses not only cognitive development but also emotional, spiritual, and physical aspects. The research explored how integrating these holistic approaches into education can foster a more comprehensive understanding of subjects and a deeper connection to the natural world. The authors stress the importance of involving indigenous communities in

the educational process. By collaborating with indigenous elders, leaders, and knowledge keepers, educators can ensure that the incorporation of indigenous perspectives is done respectfully and accurately.

Snively and Williams (2010) discuss how weaving indigenous pedagogies into education can contribute to the preservation and revitalization of indigenous languages, traditions, and knowledge systems. This, in turn, supports the cultural resilience of indigenous communities. The research also addresses the challenges and opportunities associated with implementing indigenous pedagogies. It acknowledges that this integration requires a shift in educational paradigms and may face resistance. However, it also highlights the potential benefits for both indigenous and non-indigenous students.

Educators and curriculum developers can use this research as a guide for integrating indigenous perspectives and knowledge into their curricula. This can be done across various subjects, ensuring a more inclusive and culturally sensitive approach to teaching. Teacher training programs can incorporate the ideas presented in this research to prepare educators to work effectively with diverse student populations. This includes developing an understanding of indigenous cultures, histories, and pedagogical approaches.

Building partnerships with indigenous communities can help educational institutions ensure that the incorporation of indigenous pedagogies is done in a culturally sensitive and respectful manner. Snively and Williams' research serves as a compelling call to action for educators and policymakers to embrace the rich cultural heritage and knowledge of indigenous peoples in educational settings. By weaving indigenous and education pedagogies, we can create learning experiences that foster intercultural competence, cultural relevance, and holistic understanding, ultimately promoting a more inclusive and equitable education system.

Schoenfeld (2011) argued that Indigenous knowledge encompasses the wisdom, skills, and practices developed by Indigenous communities over generations. In Southern Province, Zambia, Indigenous knowledge may involve traditional farming techniques, navigation, or cultural practices that inherently involve mathematical concepts. This knowledge is often passed down through oral traditions and is deeply rooted in the culture and daily lives of Indigenous communities. Many Indigenous students in Southern Province face challenges in mainstream mathematics education. The curriculum often lacks cultural relevance, making it difficult for students to connect with the subject. As a result, students may disengage or struggle to grasp mathematical concepts, hindering their academic progress. By incorporating Indigenous knowledge, mathematics becomes more culturally relevant for students in Southern Province. They can see the connections between their cultural traditions and mathematical concepts, making the subject more relatable and meaningful.

Incorporating Indigenous knowledge into mathematics education in Southern Province, Zambia, can significantly benefit Indigenous students. It makes mathematics more relevant, engaging, and culturally meaningful, ultimately leading to improved learning outcomes and the preservation of Indigenous heritage. By embracing Indigenous knowledge, we can create a more inclusive and empowering educational experience for all students in the region.

Mathematics educators in Southern Province have a crucial role to play in addressing this cultural clash. They must recognize their responsibility to create an inclusive and culturally sensitive learning environment. This involves not only acknowledging Indigenous students' cultural backgrounds but also actively incorporating Indigenous knowledge and practices into the mathematics curriculum. Mathematics educators should collaborate with local Indigenous communities to adapt the curriculum. This process may involve integrating traditional Indigenous mathematical concepts, problem-solving methods, and relevant cultural examples into the mathematics curriculum. Teachers should receive training on culturally responsive teaching methods, enabling them to connect with their Indigenous students and bridge the gap between Western and Indigenous mathematics.

Meaney et al. (2021) emphasize the importance of reflexivity and active listening in discussions about mathematics education for Indigenous students. Non-Indigenous educators need to reflect on their assumptions and engage in meaningful dialogue with Indigenous communities to better understand their needs and aspirations. This approach can inform the indigenization of mathematics education in Southern Province, Zambia. The work of Meaney et al. (2021) underscores the crucial role of reflexivity and active listening in discussions surrounding mathematics education for Indigenous students. This perspective is highly relevant not only in the context Meaney et al. (2021) examined but also in various regions, including Southern Province, Zambia, where Indigenous populations have unique cultural and educational needs.

Reflexivity involves educators critically examining their own assumptions, biases, and preconceived notions when engaging with Indigenous communities. It's crucial for non-Indigenous educators to recognize that their perspectives may be shaped by dominant Western paradigms and may not align with the values and worldviews of Indigenous students and their communities.

Active listening is a fundamental aspect of effective communication. In the context of Indigenous education, it means not only hearing but truly understanding the perspectives, experiences, and aspirations of Indigenous students and their communities. Active listening helps in building trust and respect, which are essential for meaningful collaboration. Non-Indigenous educators should engage in meaningful, ongoing dialogues with Indigenous communities. This dialogue should prioritize the voices of Indigenous students, parents, elders, and community leaders. Through these conversations, educators can gain valuable insights into the specific challenges faced by Indigenous students in learning mathematics and identify culturally appropriate strategies for teaching.

Beyond curriculum adaptation, meaningful engagement with Indigenous communities empowers them to take an active role in shaping their children's education. It may involve co-designing educational programs and resources, ensuring that education reflects the aspirations and goals of the community. Non-Indigenous educators should engage in professional development opportunities that focus on cultural competence, Indigenous pedagogies, and the history and context of Indigenous education. Collaborating with Indigenous educators and experts can also be a valuable way to bridge gaps in understanding and expertise.

To successfully indigenize mathematics education in Southern Province, Zambia, it's essential to have support at the policy and institutional levels. Policies should be developed or revised to reflect the principles of Indigenous education and to encourage the integration of Indigenous knowledge and practices into the curriculum. Continuous assessment and evaluation are necessary to ensure that the indigenization of mathematics education is effective. This includes monitoring student performance, gathering feedback from Indigenous communities, and adjustments as needed to improve outcomes.

Policy Review and Teacher Training in using indigenized teaching approaches

McCarty et al. (2017) argue that culturally relevant education is vital in today's diverse world, emphasizing the importance of incorporating diverse cultural perspectives, especially indigenous knowledge, into the education system. To achieve this, two key components are essential: supportive policies and teacher training programs. Policies should recognize indigenous cultures, languages, and traditions, promote their inclusion in the curriculum, and allocate resources for materials and teacher training. Teacher training programs should focus on cultural competence, pedagogical strategies, and collaboration with indigenous communities. The synergy between policies and teacher training creates a sustainable ecosystem for culturally relevant education.

Brown et al. (2018) conducted a study on urban elementary teachers implementing culturally relevant education in science and math. They found that teachers struggled to apply CRE principles effectively due

to challenges like resource scarcity, curriculum alignment, and teacher preparedness. Professional development is crucial to bridge this gap, emphasizing awareness, training, resource development, collaboration, and ongoing learning. CRE not only enhances academic achievement but also fosters a sense of belonging among students in diverse urban settings.

To effectively indigenize pedagogies, mathematics educators in Southern Province need specialized training that not only enhances their subject matter knowledge but also equips them with the cultural competence required to connect with students in this specific context. Investigate how teacher training programs in the region can be adapted to foster a deeper understanding of local culture and history, which can, in turn, inform pedagogical approaches.

Hu et al. (2019) stress the significance of culturally relevant curriculum materials in today's digital age of social media and content curation. They argue that these materials should reflect students' diverse backgrounds, going beyond mere token representation. Teacher educators are highlighted as key players in creating, disseminating, and integrating these materials into teacher training programs and classrooms. The authors emphasize the need for careful curation to counterbalance potential biases in the digital landscape.

Boutte (2012) addresses the underrepresentation of elementary education in urban schools in academic discourse. The study emphasizes the importance of recognizing and addressing challenges faced by urban elementary educators, such as overcrowded classrooms and limited resources. It calls for investments in teacher preparation and ongoing professional development and advocates for policy changes and community engagement to support urban elementary schools.

Hogarth (2022) explored the lack of training for teachers transitioning into educational leadership roles, emphasizing the skills gap and challenges in offering relevant training. The study highlights the importance of mentorship, peer support, and tailored training programs for effective leadership development, with implications for indigenizing mathematics education through community collaboration and culturally tailored training.

Kennedy (2016) categorizes professional development programs based on their underlying theories and strategies. The review underscores the importance of understanding the theories and purposes behind such programs, emphasizing their role in improving teaching practices. This understanding can be applied to designing effective professional development initiatives for teachers in various contexts, including those focused on indigenizing mathematics education.

Kennedy's study focuses on categorizing and understanding the diverse landscape of professional development programs for educators. These programs vary widely in content, format, and duration, addressing different aspects of teaching. The research emphasizes that there is no one-size-fits-all approach to professional development, as programs are driven by different underlying theories of action.

Key takeaways from Kennedy's research include the importance of educators understanding the theoretical foundations of professional development programs to align them with their teaching philosophies and goals. Some programs may emphasize specific skills, while others focus on critical thinking and problem-solving. It also highlights the need for alignment between program goals and desired student outcomes, ensuring that strategies employed have a positive impact on learning and classroom dynamics.

The study also points out a lack of research in evaluating policy changes and teacher training programs in promoting culturally relevant mathematics education. Kennedy's work contributes by investigating innovative approaches to incorporating indigenous knowledge into the mathematics curriculum in Southern Province, Zambia. It involves various stakeholders, including students, teachers, community members, and education authorities, to provide a comprehensive understanding of the challenges and opportunities in

indigenizing mathematics education. This research sheds light on the practical implementation of culturally relevant education in the context of mathematics through the examination of policy support, teacher training, and curriculum modification.

The literature review underscores the significance of indigenizing mathematics education to enhance cultural relevance and engagement among students. While the literature highlights the importance of culturally relevant pedagogy and indigenous knowledge integration, it also reveals gaps in empirical research and practical implementation. The present research sought to address these gaps by offering practical insights and empirical evidence, contributing to the ongoing dialogue on culturally relevant mathematics education in Southern Province, Zambia, and beyond.

METHODOLOGY

Research Design

The research design used in this study was a Mixed Methods Sequential Explanatory Design. Ivankova and Creswell (2006) articulate that Mixed Methods Sequential Explanatory Design is a research approach that combines qualitative and quantitative methods in a sequential manner to provide a comprehensive understanding of a research problem. It involves collecting and analyzing quantitative data first, followed by collecting and analyzing qualitative data to explain or elaborate on the quantitative findings. The integration of both types of data occurs during the interpretation and reporting stages of the research process. This sequential approach allows for a comprehensive exploration of the research questions by combining the strengths of both quantitative and qualitative research methods.

McCrudden and McTigue (2018) argues that the Mixed Methods Sequential Explanatory Design offers a valuable approach for researchers to gain a deeper understanding of complex research problems by combining the strengths of qualitative and quantitative methods. It allows for a more comprehensive exploration of research questions and provides a more nuanced understanding of the phenomena under investigation.

Study population

In the current research study on indigenous pedagogies in mathematics education, a diverse sample of participants was carefully selected to ensure comprehensive coverage of perspectives within the research context. The study employed both quantitative and qualitative research methods to gather data and gain a deeper understanding of the topic.

The study involved a diverse set of participants, carefully selected to ensure comprehensive coverage of perspectives within the research context. The quantitative sample size was $N=326$, consisting of 55 mathematics teachers and 271 Grade 12 students. The qualitative Sample involved in the study was ($N=17$): A selection of community members was included to provide a community perspective on the integration of indigenous pedagogies. The District Education Board Secretary's office was represented to offer insights into the institutional perspective. School administrators were included to understand the viewpoint of those responsible for educational administration at the school level. The participants' characteristics and roles were diverse, to ensure that the study captures a broad range of perspectives related to indigenous mathematics education.

The quantitative sample was determined by using the online sample size calculator and the qualitative sample was determined purposefully. The inclusion of community members provides a community perspective on the integration of indigenous pedagogies in mathematics education. Representatives from

the District Education Board Secretary's office were included to offer insights into the institutional perspective. The school administrators were included to understand the viewpoint of those responsible for educational administration at the school level.

Data collection methods

Data collection methods used in this study encompass a variety of approaches to gather rich and comprehensive data. Quantitative data was collected through structured questionnaire surveys administered to mathematics teachers and Grade 12 pupils. These surveys included closed-ended questions to quantify participants' perceptions, experiences, and attitudes toward indigenous pedagogies.

Qualitative data was gathered through in-depth interviews with community members, the DEBS representative, and school administrators. These semi-structured interviews allowed for open-ended discussions and exploration of participants' perspectives. Focus group discussions were conducted with selected participants to facilitate group dynamics and elicit collective insights. Observations of mathematics classes were carried out to assess the practical implementation of indigenous pedagogies and to observe the level of student engagement and participation in these classes. Relevant documents, including curriculum materials, policy documents, and educational resources were analyzed to provide contextual information and support the interpretation of findings.

Data analysis

The quantitative data from the surveys was analyzed using descriptive statistics tools. This involved calculating measures such as mean, standard deviation, and frequency distributions to summarize and interpret quantitative findings. Various statistical tests such as t-tests, and ANOVA were also used to analyze quantitative data.

The study used reflexive thematic analysis to analyze the qualitative data. Reeping et. al (2019) states that thematic analysis is a commonly used approach in qualitative data analysis, which involves identifying patterns, themes, and categories within the data. This process involved identifying recurring themes, patterns, and narratives within the qualitative data, allowing for a deeper understanding of participants' perspectives and experiences.

Credibility, reliability, and trustworthiness

Creswell and Plano (2017) argues that credibility, reliability, and trustworthiness stand as paramount considerations when evaluating the quality and validity of data derived from a mixed methods study. Credibility, at its core, pertains to the degree to which the data can be deemed believable and authentic. In the context of this study, credibility received a significant boost through the deliberate utilization of multiple data sources and varied research methods, thereby establishing a triangulation of findings. By drawing from diverse perspectives and sources, the researcher succeeded in achieving convergence and consistency in the findings, thereby elevating the overall credibility of the study.

Johnson and Onwuegbuzie (2004) contends that trustworthiness, on the other hand, encompasses the concept of the data's integrity and dependability. Within the confines of this study, trustworthiness was bolstered through two pivotal avenues: transparency and reflexivity. Triangulation, recognized as a cornerstone strategy in mixed methods research, was instrumental in fortifying credibility, reliability, and trustworthiness. This method entails the deployment of multiple data sources, various research techniques, and a multitude of viewpoints to corroborate and substantiate findings. Through the process of comparing and contrasting distinct data types, the researcher was able to augment the study's overall validity and trustworthiness.

Tashakkori and Teddlie (2010) argues that reflexivity, as an integral component of trustworthiness, refers to the researcher's conscientious recognition of their personal biases, presumptions, and vantage points that could potentially exert influence on the research process. The researcher actively engaged in an ongoing practice of self-reflection and critical self-awareness to ensure that the inherent biases did not exert undue sway over the data collection and analysis phases. This proactive approach bolstered the study's trustworthiness by acknowledging and proactively addressing potential sources of bias.

Morse (2015) emphasizes the importance of transparency in research, asserting that it plays a crucial role in establishing the credibility, reliability, and trustworthiness of data. To achieve transparency, researchers should offer clear and thorough explanations of their research design, data collection methods, and analytical approaches. This transparency allows readers to assess the study's rigor and validity, ultimately enhancing the trustworthiness of the data.

Ethical considerations

Ethical considerations play a pivotal role in every stage of this research. Participants were provided with clear, written information about the study's purpose, procedures, potential risks, and benefits. They were requested to provide voluntary, informed consent before participating.

Participants' identities were protected through the use of pseudonyms, and all data were securely stored to ensure confidentiality. Given the cultural context of the research, cultural sensitivities and local protocols were observed during data collection and analysis to avoid any inadvertent harm or offense. The study aimed to benefit the local educational community by contributing to the improvement of mathematics education practices and promoting cultural inclusivity.

PRESENTATION OF RESULTS AND DISCUSSION

Overview:

The research objective at the heart of this presentation and discussion of results is to explore the potential ways of indigenizing pedagogies and practices in teaching mathematics. This objective emerges from a recognition of the diverse cultural backgrounds and perspectives that students bring to the classroom. It also acknowledges the importance of honoring and integrating indigenous knowledge and practices into the mathematics curriculum, thereby promoting a more inclusive, effective, and relevant educational experience for all learners.

In the following presentation, we explored into the results of this research, which have been derived through a comprehensive analysis of various approaches, strategies, and case studies aimed at indigenizing mathematics education.

The potential ways of indigenizing pedagogies and practices in teaching mathematics

The objective of this study explored possible approaches to incorporate indigenous perspectives and methods into the teaching of mathematics. This objective aimed to tackle the persistent challenge of effectively engaging students in mathematics education, especially when faced with content that might feel disconnected from their cultural contexts. The primary goal of this research objective was to recognize, examine, and suggest practical strategies for infusing indigenous knowledge, values, and epistemologies into mathematics instruction.

The table presents the mean scores for each statement, as well as the total number of respondents (N) for

each statement. The grand mean, which represents the average score across all statements, is also provided.

Table 1: Views of participants on the potential ways of indigenizing pedagogies and practices in teaching mathematics

Descriptive Statistics	N	Mean
I believe that incorporating indigenous cultural perspectives in mathematics education can enhance students' understanding of mathematical concepts	55	4.15
Integrating indigenous cultural practices into mathematics education can promote cultural diversity and inclusivity in the classroom	55	3.96
Indigenous knowledge systems and practices can be integrated into teaching mathematics	55	4.16
Introducing traditional Zambian games and puzzles in mathematics lessons can make the subject more interesting and relevant to students	55	4.38
Incorporating local examples, stories, and cultural practices in mathematics problems can help students understand concepts better.	55	4.33
Teaching mathematics in local languages can help students who struggle with English to better understand the subject.	55	3.98
I am comfortable with using indigenous knowledge systems and practices in teaching mathematics	55	3.73
Incorporating indigenous perspectives in mathematics education can improve students' engagement and motivation in the subject	55	4.15
Incorporating indigenous knowledge systems in mathematics education can foster a deeper understanding and appreciation of the subject	55	4.07
I am comfortable with adapting existing mathematics curriculum to include indigenous perspectives	55	4
I am willing to collaborate with indigenous community members or elders to develop culturally relevant mathematics activities	55	4.11
Grand Mean	55	4.092727

The mean scores for each statement range from 3.73 to 4.38, with the grand mean being 4.092727. These scores indicate a generally positive attitude towards incorporating indigenous cultural perspectives in mathematics education. The high mean scores suggest that the respondents believe that integrating indigenous cultural practices and knowledge systems can enhance students' understanding of mathematical concepts, promote cultural diversity and inclusivity in the classroom, and make the subject more interesting and relevant to students.

The statement with the highest mean score (4.38) is "Introducing traditional Zambian games and puzzles in mathematics lessons can make the subject more interesting and relevant to students." This suggests that the respondents strongly agree that incorporating traditional games and puzzles can enhance students' engagement and motivation in mathematics.

The statement with the lowest mean score (3.73) is "I am comfortable with using indigenous knowledge systems and practices in teaching mathematics." This indicates that while the majority of respondents are comfortable with incorporating indigenous perspectives in mathematics education, there is a subset of respondents who may have reservations or concerns about using indigenous knowledge systems and

practices.

The grand mean of 4.092727 indicates an overall positive attitude towards incorporating indigenous perspectives in mathematics education. This suggests that the respondents recognize the potential benefits of integrating indigenous cultural practices and knowledge systems in teaching mathematics.

The study has reviewed several potential ways of indigenizing the teaching of mathematics education in Zambia.

Making Mathematics Culturally Relevant

The study has revealed that one of the possible approaches to incorporate indigenous methods into the teaching of mathematics was that of making mathematics culturally relevant. Culturally relevant mathematics education (CRME) is an approach to teaching mathematics that integrates students' cultural backgrounds and experiences into the learning process. This approach has gained attention and recognition for its numerous benefits, both in terms of academic achievement and social development.

The study revealed that one promising approach to indigenizing mathematics education is to make mathematics culturally relevant. Flores (2015) argued that this involves incorporating local cultural practices, traditions, storytelling, dances, music, and games into mathematics instruction. By doing so, abstract mathematical concepts are connected to students' lived experiences and cultural backgrounds. This approach has the potential to significantly increase students' engagement and motivation in learning mathematics. Mathematics education has long been a subject of debate, especially when it comes to engaging and motivating students from diverse cultural backgrounds. The conventional approach to teaching mathematics often disconnects students from their lived experiences and cultural heritage, leading to disengagement and underachievement. However, this research suggests that an effective way to address this issue is to indigenize mathematics education by making it culturally relevant.

One of the key components of culturally relevant mathematics education is the incorporation of local cultural practices. This could include using traditional tools or methods that are relevant to a particular culture to teach mathematical concepts. For example, teaching geometry through indigenous weaving patterns or trigonometry through navigation techniques used by a specific community. Gómez (2017) argues that traditions hold a significant place in every culture. By incorporating cultural traditions into mathematics instruction, educators can create a bridge between the classroom and the students' cultural heritage. This might involve solving mathematical problems related to traditional ceremonies, agricultural practices, or historical events.

Powell, Frankenstein., and Powell (2017) argued that storytelling is a powerful tool for conveying abstract concepts in a culturally relevant way. Teachers can use local folktales or historical narratives to illustrate mathematical ideas. This not only makes the content more engaging but also helps students see the practical applications of mathematics in their culture's stories. Music and dance are integral aspects of many cultures. These can be used to teach mathematical concepts related to rhythm, patterns, and symmetry. For instance, exploring the mathematical properties of traditional dance steps or musical compositions can be a captivating way to connect math with culture.

Incorporating traditional games and puzzles from different cultures can make learning mathematics enjoyable and meaningful. These games often involve strategic thinking, problem-solving, and mathematical principles, which can be seamlessly integrated into the curriculum.

The figure below summarizes the benefits of culturally relevant mathematics education

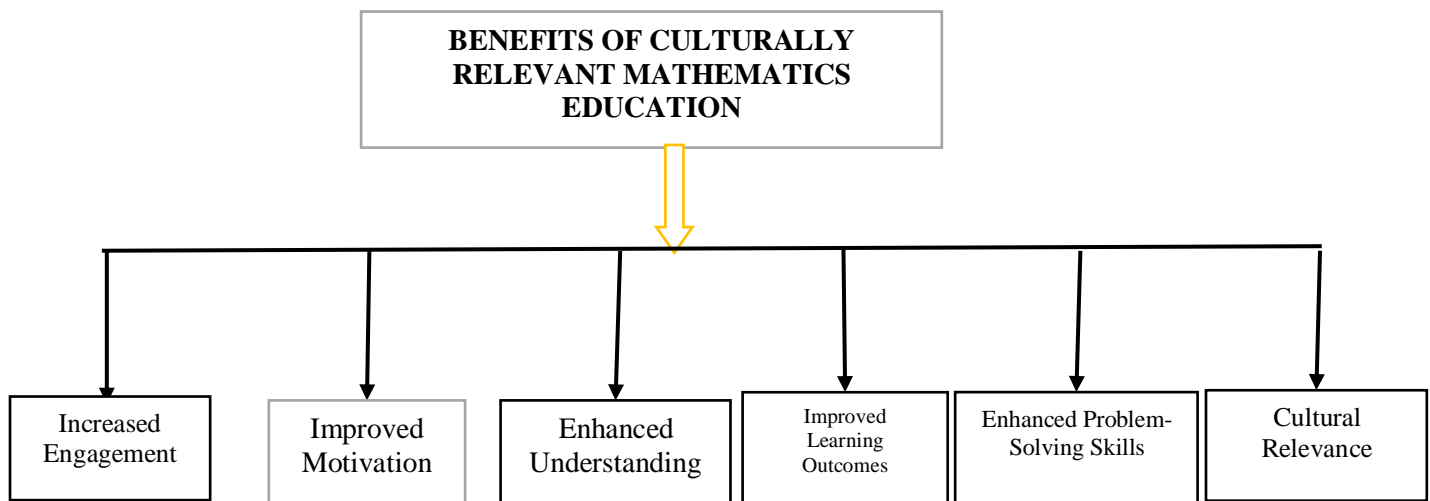


Figure 1: : Benefits of culturally relevant mathematics education

Integrating indigenous knowledge into mathematics education

The study has revealed that integrating indigenous knowledge into mathematics education could be the possible approaches to incorporate indigenous methods into the teaching of mathematics. The study underscored the significance of integrating indigenous knowledge into mathematics education. The willingness to incorporate indigenous knowledge and practices is essential in this regard. Indigenous knowledge systems offer unique problem-solving techniques and mathematical insights that enrich mainstream mathematical education. Such integration promotes a holistic understanding of mathematics and encourages students to appreciate the cultural contributions to the field.

Naidoo (2021) discusses the integration of indigenous knowledge and culturally based activities in South African mathematics classrooms. The study found that integrating culturally based activities scaffold mathematics lessons and promoted a deeper understanding of mathematical concepts, making learning more meaningful and relevant. Naidoo's (2021) study on the integration of indigenous knowledge and culturally based activities in South African mathematics classrooms sheds light on a significant and transformative approach to mathematics education. The research findings highlight the positive impact of incorporating cultural elements into the teaching and learning of mathematics, and how this can lead to more meaningful and relevant educational experiences. South Africa is a diverse nation with a rich tapestry of cultures and languages. By integrating indigenous knowledge and culturally based activities into mathematics classrooms, educators can create an inclusive and culturally responsive learning environment. This approach recognizes and respects the diversity of students' backgrounds, fostering a sense of belonging and cultural pride.

Mathematics is often perceived as abstract and disconnected from students' everyday lives. However, Naidoo's study shows that when mathematics is taught through culturally relevant activities, students can better relate to the subject matter. This increased relevance makes mathematics more engaging and motivates students to learn. The study highlights how culturally based activities can serve as scaffolds for teaching mathematical concepts. These activities provide students with real-world contexts that help them grasp abstract mathematical ideas more easily. For example, using traditional storytelling or indigenous games can illustrate mathematical principles in a relatable way.

Integrating indigenous knowledge and culturally based activities deepens students' understanding of

mathematical concepts. When students see the connections between their culture and mathematics, they are more likely to explore mathematical concepts in greater depth. This promotes a deeper, more profound understanding of the subject. Incorporating cultural elements into mathematics education encourages a holistic approach to learning. It recognizes that education should not be limited to rote memorization of formulas and procedures but should encompass a broader understanding of the world. Students learn not only mathematics but also gain insights into their own culture and its mathematical foundations.

Owuor (2008) explored the potential for integrating African indigenous knowledge into Kenya's formal education system. The study discusses the challenges and possibilities of involving indigenous community members as facilitators of the learning process, highlighting the importance of valuing and incorporating indigenous knowledge systems. Owuor's study (2008) served as a crucial stepping stone in recognizing the importance of integrating African indigenous knowledge into Kenya's formal education system. While challenges such as lack of recognition, language barriers, and curriculum misalignment existed, the study also highlighted viable possibilities for bridging the gap. Involving indigenous community members, adapting the curriculum, promoting cultural exchange, and preserving native languages are essential steps toward valuing and incorporating indigenous knowledge systems into Kenya's modern education framework. This integration not only enriches the education experience but also helps preserve and celebrate the rich heritage of indigenous communities.

Meaney and Evans (2012) discuss the responsibility of mathematics education to Indigenous students. The research emphasizes the need for mathematics education to support students' transitions between contexts, including their home communities, and highlights the importance of valuing Indigenous practices in their original contexts. Indigenous communities often have their unique ways of knowing, problem-solving, and using mathematics. Recognizing and respecting this diversity is essential. Mathematics education should be flexible and adaptable to incorporate Indigenous cultural perspectives. Many Indigenous students move between their home communities and mainstream educational institutions. Mathematics education should help bridge the gap between these contexts by making learning relevant in both settings. This can involve incorporating traditional knowledge and contextualizing mathematics within Indigenous cultural contexts.

Nutti (2013) examined the experiences of Indigenous teachers implementing culture-based mathematics activities in Sámi schools. The study suggests that integrating Indigenous culture-based knowledge with national school mathematics teaching can improve academic performance and promote cultural preservation. This research underscores the importance of integrating Indigenous knowledge and culture into mainstream education, shedding light on its potential benefits for both academic achievement and cultural preservation. Nutti's (2013) research sheds light on the transformative potential of integrating Indigenous culture-based knowledge into mainstream education, especially in contexts like Sámi schools. This approach not only improves academic performance but also plays a crucial role in preserving Indigenous cultures, fostering a strong sense of identity, and creating a positive ripple effect throughout Indigenous communities and society as a whole. It calls for a holistic approach to education that values cultural diversity and recognizes its significance in the learning process.

The implications of these results are significant. Incorporating indigenous cultural perspectives in mathematics education can enhance students' understanding of mathematical concepts, promote cultural diversity and inclusivity in the classroom, and improve students' engagement and motivation in the subject. By incorporating local examples, stories, and cultural practices in mathematics problems, students can develop a deeper understanding and appreciation of the subject. Additionally, teaching mathematics in local languages can help students who struggle with English to better understand the subject.

To fully realize the potential benefits of incorporating indigenous perspectives in mathematics education, it is important for educators to be comfortable with using indigenous knowledge systems and practices.

Collaboration with indigenous community members or elders can also be valuable in developing culturally relevant mathematics activities.

When exploring the potential ways of indigenizing the pedagogies and practices in teaching mathematics in three selected secondary schools in Southern Province, Zambia, several themes emerged during the study. Below is a figure summarizing the major themes that were generated during the study:

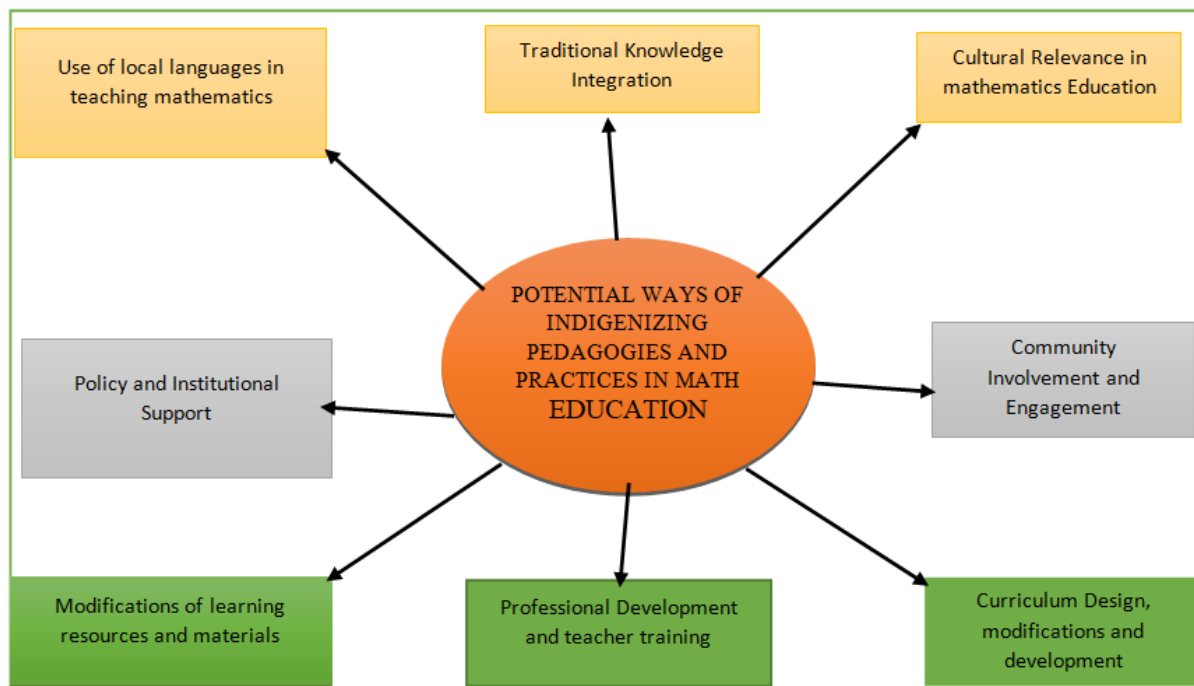


Figure 2: Themes generated from the potential ways of indigenizing pedagogies and practices in teaching mathematics

The first theme that emerged from the qualitative results as one of the potential ways of indigenizing pedagogies and practice in the teaching of mathematics was that of integrating traditional knowledge in the teaching of mathematics.

Participant 1: “I think integrating traditional knowledge in the teaching of mathematics is crucial because it adds cultural relevance to the subject. Mathematics can sometimes feel abstract and disconnected from our daily lives, but when we incorporate traditional knowledge from different cultures, it becomes more relatable and meaningful.”

Participant 1 emphasized the significance of integrating traditional knowledge in the teaching of mathematics. This sentiment aligns with the notion that mathematics education should be culturally relevant and meaningful. Stylianides and Stylianides (2013) argues that mathematics education should be viewed from a cultural perspective, acknowledging the diverse ways in which mathematics is understood and practiced across different cultures. By incorporating traditional knowledge, mathematics becomes more relatable and connected to students’ daily lives.

Setati (2005) explores the role of indigenous knowledge in mathematics education in South Africa. The author argues that indigenous knowledge can enhance students’ understanding of mathematics by providing alternative ways of solving problems and different perspectives on mathematical concepts. This aligns with Participant 1’s perspective on the importance of integrating traditional knowledge in mathematics education.

The integration of traditional knowledge in the teaching of mathematics has several implications for mathematics education. Firstly, it promotes cultural relevance and inclusivity in the classroom. Frideres

(2010) emphasizes that incorporating indigenous knowledge in education is a way to acknowledge and validate the cultural heritage and contributions of indigenous communities. By integrating traditional knowledge in the teaching of mathematics, educators can create a learning environment that respects and values diverse cultural perspectives.

Secondly, the integration of traditional knowledge can enhance students' engagement and understanding of mathematical concepts. Castagno & Brayboy (2008) argue that culturally responsive schooling, which includes the integration of traditional knowledge, can improve academic outcomes for indigenous youth. By incorporating traditional knowledge, mathematics becomes more meaningful and relatable to students, as it connects to their cultural experiences and ways of knowing.

Furthermore, integrating traditional knowledge in mathematics education can contribute to the professional development of teachers. Evens et al. (2018) highlight the importance of integrating content and pedagogy in teacher education. By incorporating traditional knowledge in mathematics instruction, teachers can deepen their understanding of mathematical concepts and develop pedagogical strategies that are culturally responsive. This can lead to more effective teaching practices and improved student learning outcomes.

Lastly, the integration of traditional knowledge in mathematics education can challenge Eurocentric perspectives and broaden the understanding of mathematics as a discipline. Stevens (2021) conducted a study on the perceptions and uses of mathematics in the San Carlos Apache community and found that indigenous communities have their own cultural production of mathematics. By incorporating traditional knowledge, educators can challenge the dominant Eurocentric narrative of mathematics and promote a more inclusive and diverse understanding of the subject.

The second theme that emerged as the potential way to indigenize the pedagogies and practices in the teaching of mathematics was that of the use of cultural relevance in mathematics education. It was noted through the class observations, and the focus group discussions that one of the potential ways of indigenizing the pedagogies and practices in the teaching of mathematics was to make mathematics culturally relevant.

Participant 2: "I believe that making mathematics culturally relevant is crucial in indigenizing pedagogies. Students from diverse cultural backgrounds might struggle to connect with abstract concepts. By incorporating examples and problems that resonate with their cultures, we can increase engagement and understanding."

This theme emerged as a potential way to address the challenges faced by students from diverse cultural backgrounds in connecting with abstract mathematical concepts. The use of cultural relevance in mathematics education has been noted through class observations and focus group discussions, highlighting its potential to increase student engagement and understanding. Participant 2 emphasized the significance of making mathematics culturally relevant in indigenizing pedagogies. This viewpoint aligns with the growing body of research that supports the idea that incorporating examples and problems that resonate with students' cultures can enhance their learning experiences in mathematics.

Gutierrez (2008) argues that mathematics education should be culturally relevant to promote equity and social justice. She suggests that by incorporating culturally relevant examples and problems, educators can create a more inclusive and engaging learning environment for students from diverse cultural backgrounds. Furthermore, the work of Civil and Planas (2010) supports the idea that cultural relevance in mathematics education can enhance students' engagement and understanding. They suggest that by incorporating culturally relevant examples and problems, educators can create a bridge between students' cultural backgrounds and the abstract nature of mathematics. This bridge can help students see the relevance and applicability of mathematical concepts in their own lives, leading to increased motivation and improved

learning outcomes.

The theme reveals several implications for the teaching of mathematics and the indigenization of pedagogies. One implication is the need for teachers to purposefully plan lessons that infuse cultural relevance into their STEM classrooms. By incorporating examples and problems that resonate with students' cultures, teachers can create a more inclusive and engaging learning environment. This approach can help students from diverse cultural backgrounds connect with abstract mathematical concepts and increase their engagement and understanding

Furthermore, the concept of ethno mathematics is relevant to the discussion of cultural relevance in mathematics education. Ethno mathematics aims to make students love mathematics, get motivated, and improve creativity by incorporating cultural practices and traditions into mathematical learning. This approach recognizes the cultural diversity of students and acknowledges the importance of cultural relevance in fostering meaningful and engaging mathematical experiences.

The third theme that emerged as the potential way to indigenize the pedagogies and practices in the teaching of mathematics was that of involving and engaging the community in the teaching of mathematics.

Participant 2: "I think community involvement and engagement are crucial for indigenizing the teaching of mathematics. When we bring in local cultural elements and connect math concepts to real-life situations in our communities, it makes the subject more relevant and meaningful to our students. They can see how math is not just an abstract concept but something that has practical applications in their own lives and culture."

Involving and engaging the community in the teaching of mathematics is a potential way to indigenize pedagogies and practices in mathematics education. Research suggests that community involvement can make mathematics more relevant and meaningful for students by connecting mathematical concepts to real-life situations in their own culture. Setati (2005) explores the role of indigenous knowledge in mathematics education in South Africa. The author argues that involving the community in the teaching of mathematics can help bridge the gap between formal mathematics and indigenous knowledge systems. By incorporating local knowledge and practices, students can develop a deeper understanding of mathematical concepts and their relevance to their own culture. By incorporating local cultural elements and indigenous knowledge, teachers can create a more inclusive and culturally responsive mathematics curriculum.

The implications of the theme revealed above is significant for mathematics education. By involving and engaging the community in the teaching of mathematics, educators can make the subject more relevant and meaningful for students. This approach allows students to see the practical applications of mathematics in their own lives and culture, which can enhance their understanding and motivation. Research has shown that community involvement in mathematics education can have positive effects on student outcomes. For example, a study by Hill et al. (2005) found that teachers' mathematical knowledge for teaching was significantly related to student achievement gains. This suggests that when teachers involve the community and incorporate local knowledge and practices into their teaching, students may experience improved learning outcomes.

Furthermore, community involvement in mathematics education can help bridge the gap between formal mathematics and indigenous knowledge systems. Setati (2005) argues that by incorporating local cultural elements and connecting mathematical concepts to real-life situations in the community, students can develop a deeper understanding of mathematical concepts and their relevance to their own culture.

The fourth narrative that emerged as the potential way to indigenize the pedagogies and the practices in the teaching of mathematics was that there was need to design the new curriculum that reflects cultural elements, there was need to modify the current curriculum and develop a new curriculum that would be

aligned with the cultural elements of the society.

Participant 12: “I strongly believe that there is a need for curriculum design, modification, and development in the teaching of mathematics to indigenize the pedagogies and practices. The current curriculum often neglects the rich mathematical traditions and knowledge that exist within our indigenous communities. By incorporating their ways of learning and problem-solving, we can make mathematics more relevant and accessible to all students.”

Participant 12 emphasizes the need for curriculum design, modification, and development in order to indigenize the teaching of mathematics. The participant argued that the current curriculum often neglects the rich mathematical traditions and knowledge that exist within indigenous communities. This neglect can lead to a disconnection between students’ cultural identities and their experiences in the mathematics classroom. By incorporating indigenous ways of learning and problem-solving, mathematics can become more relevant and accessible to all students.

Incorporating cultural elements into the mathematics curriculum can help make the subject more accessible and meaningful for all students. By drawing on the ways of learning and problem-solving that are valued within indigenous communities, educators can create a curriculum that is more inclusive and responsive to the needs and experiences of indigenous students. This can also help to challenge the dominant narrative that mathematics is a universal and objective discipline, and instead recognize the diverse ways in which mathematical knowledge is constructed and applied.

To design a curriculum that reflects cultural elements, it is important to engage with indigenous communities and incorporate their perspectives and knowledge. This can be done through collaboration with community members, elders, and knowledge keepers, who can provide valuable insights into the mathematical traditions and practices of their communities. By involving indigenous voices in the curriculum development process, educators can ensure that the curriculum is respectful, accurate, and relevant.

Modifying the current curriculum and developing a new curriculum that aligns with cultural elements requires careful consideration and planning. It involves identifying the cultural elements that should be incorporated, determining how they can be integrated into the curriculum, and ensuring that the curriculum remains rigorous and aligned with educational standards. This process may also involve revisiting and rethinking the ways in which mathematics is taught and assessed, in order to better reflect the diverse ways in which mathematical knowledge is constructed and applied.

The theme that emerged has several implications for the indigenization of pedagogies and practices in the teaching of mathematics. Firstly, the need for curriculum design, modification, and development highlights the importance of incorporating cultural elements into the mathematics curriculum. This aligns with the call for decolonizing education and recognizing the rich mathematical traditions and knowledge that exist within indigenous communities (Brant, 2014). By integrating indigenous ways of learning and problem-solving, the curriculum can become more relevant and accessible to all students, including those from indigenous backgrounds.

However, it is crucial to approach the indigenization of the curriculum with caution. The process should not imply the application of an “impoverished” version of indigenous pedagogy or promote corrupted understandings of indigenous knowledge. Instead, it should involve respectful engagement with indigenous communities and the incorporation of their perspectives and knowledge in a way that is accurate and relevant.

Creating a curriculum that reflects cultural elements requires collaboration with indigenous communities

and the involvement of community members, elders, and knowledge keepers (Funk & Woodroffe, 2023). This collaborative approach ensures that the curriculum is respectful and aligned with the ways of knowing and learning valued within indigenous communities (Brown, 2010). It also helps challenge the dominant narrative that mathematics is a universal and objective discipline, recognizing the diverse ways in which mathematical knowledge is constructed and applied.

In addition to curriculum design, modification, and development, the results suggest the importance of nurturing relationships within a space created by “indigenous ways of knowing” (Brown, 2010). This highlights the need for educators to create a supportive and culturally responsive learning environment that allows students to connect spiritually and personally with themselves, their peers, and their educators. Such an environment can enhance student engagement and promote a sense of belonging, particularly for indigenous students.

The study revealed that one of the potential ways to indigenize the teaching of mathematics was the Mathematization of everyday.

Participant 8 “Math is everywhere in my daily life, from calculating my monthly budget to measuring ingredients for recipes. It helps me make informed decisions.”

Participant 8’s statement highlights the concept of Mathematization of everyday, which refers to the integration of mathematics into everyday activities and experiences. This approach recognizes that mathematics is not limited to the classroom but is present in various aspects of our lives. The participant mentions two specific examples of how mathematics is utilized in their daily life. Firstly, they mention calculating their monthly budget. This involves various mathematical concepts such as addition, subtraction, multiplication, and division. By using mathematics, the participant is able to manage their finances effectively and make informed decisions about their spending and saving habits.

Secondly, the participant mentions measuring ingredients for recipes. Cooking and baking often require precise measurements, which involve mathematical concepts such as fractions and ratios. By applying mathematical skills, the participant is able to follow recipes accurately and achieve desired outcomes in their culinary endeavors.

The participant’s statement highlights the practicality and relevance of mathematics in everyday life. It demonstrates that mathematics is not just an abstract subject taught in schools but has real-life applications and implications. By recognizing and embracing the Mathematization of everyday, educators can make mathematics more relatable and meaningful to students.

This finding aligns with the broader goal of indigenizing the teaching of mathematics. Indigenization refers to the incorporation of indigenous knowledge, perspectives, and practices into educational systems. By integrating mathematics into everyday experiences, educators can bridge the gap between traditional indigenous knowledge and Western mathematical concepts.

The implications of the results that emerged from this theme has significant implications the teaching and learning of mathematics. Firstly, integrating mathematics into everyday experiences can help students develop a positive attitude towards the subject. The study participant’s statement highlights how mathematics is used in practical situations such as budgeting and cooking. By demonstrating the relevance of mathematics in real-life contexts, students may develop a greater appreciation for the subject and see its value beyond the classroom.

Secondly, the Mathematization of everyday can enhance students’ understanding of the nature of mathematics. By experiencing mathematics in their daily lives, students can gain a deeper understanding of

its concepts, applications, and problem-solving strategies. This alternative perspective to mathematics can help students see the subject as more than just a set of abstract rules and formulas, but as a tool for understanding and navigating the world around them.

Furthermore, integrating mathematics into everyday experiences can help alleviate math anxiety. Math anxiety is a common phenomenon that can hinder students' performance and engagement in mathematics (Ashcraft, 2002). By showing students that mathematics is not confined to the classroom but is present in their daily lives, educators can help reduce anxiety and create a more supportive and inclusive learning environment (Finlayson, 2014).

Additionally, the Mathematization of everyday can promote the development of critical thinking and problem-solving skills. By engaging with mathematics in practical situations, students are encouraged to think critically, analyze data, and make informed decisions. These skills are essential for success in various academic and professional domains (Morsanyi et al., 2014).

The study also revealed that one of the ways to indigenize the teaching of mathematics was the use of local language in the teaching of mathematics.

Participant 13: "I've seen students who were previously disengaged suddenly light up when they can express themselves in their mother tongue. It helps them understand the concepts better and builds their confidence." "Absolutely! I've noticed that students who struggle with English or other second languages often get left behind in math class. When we use their native language, they can connect with the material and actively participate in discussions. It's like breaking down a barrier that was hindering their learning."

The use of local language in the teaching of mathematics has been found to have positive effects on students' engagement, understanding of concepts, and confidence. This finding is supported by several studies in the field of mathematics education.

One study by Adiguzel and Kocak (2016) investigated the effect of using mother tongue in mathematics teaching on students' academic achievement. The researchers found that students who were taught mathematics in their mother tongue performed significantly better than those who were taught in a second language. This suggests that using local language in mathematics instruction can enhance students' learning outcomes.

Another study by Bao and Lam (2018) reviewed the literature on the role of language in mathematics learning. The authors found that language plays a crucial role in students' understanding of mathematical concepts. When students are able to express themselves in their mother tongue, they can better connect with the material and actively participate in discussions. This not only improves their comprehension but also breaks down language barriers that may hinder their learning.

The importance of using local language in mathematics teaching is further emphasized by the work of Cummins (2000) and Setati and Adler (2000). Cummins argues that language is a source of power and pedagogy, and using students' native language can empower them in their learning. Setati and Adler highlight the role of language in learning mathematics, stating that students' language proficiency can impact their ability to understand and solve mathematical problems.

The results that emerged from this theme have several implications in the teaching of mathematics. Firstly, the use of local language in the teaching of mathematics can enhance students' engagement, understanding, and confidence. This suggests that educators should consider incorporating local language into their mathematics instruction to create a more inclusive and effective learning environment. By doing so, students who struggle with English or other second languages can better connect with the material and actively

participate in discussions, breaking down language barriers that hinder their learning.

Secondly, the findings highlight the importance of providing continued professional support for teachers in multilingual classrooms (Gresham, 2017). Teacher education programs should consider addressing the use of local language in mathematics instruction and providing strategies for effectively incorporating it into the classroom. This support can help teachers navigate the challenges and maximize the benefits of using local language in mathematics teaching.

Furthermore, the findings suggest that using local language in mathematics teaching can contribute to the indigenization of the curriculum. Indigenizing the curriculum involves challenging and reversing racist and colonial ideologies, providing meaningful alternatives within school cultures, and supporting the dynamic learning of Indigenous students (Stavrou, 2021). By incorporating local language, educators can promote the cultural relevance and inclusivity of mathematics education, particularly for Indigenous students. Top of Form

CONCLUSION AND RECOMMENDATIONS

Conclusion

The importance of making mathematics culturally relevant by incorporating local cultural practices, traditions, storytelling, dances, music, and games is emphasized in the study. This approach not only increases students' engagement and motivation but also connects abstract mathematical concepts to their lived experiences and cultural backgrounds. The significance lies in fostering a deeper connection between students and mathematics, making learning more meaningful.

The positive reception of indigenizing pedagogies in mathematics education aligns with the concept of culturally relevant pedagogy. This approach connects education to students' cultural backgrounds, enhancing engagement and meaning-making in learning. The significance lies in promoting effective teaching methods that resonate with students' cultural contexts.

The convergence of quantitative and qualitative findings provides a comprehensive understanding of the positive reception towards integrating indigenous cultural perspectives in mathematics education. The quantitative results reveal a collective enthusiasm, with mean scores affirming a favorable disposition towards this integration. Specifically, the resonance with traditional Zambian games and puzzles highlights a shared belief in the potential to enhance student interest and relevance in the subject through culturally-rooted activities.

The qualitative insights further underscore the significance of this integration, offering actionable strategies for indigenizing pedagogies in mathematics education. The emergence of four key themes – integrating traditional knowledge, using cultural relevance, involving the community, and incorporating local language – illuminates avenues to create a more inclusive and culturally rich learning environment.

By incorporating traditional knowledge, educators not only add cultural significance to mathematics but also make it more relatable and meaningful for students from diverse backgrounds. Making mathematics culturally relevant addresses the challenge of connecting abstract concepts with students' lived experiences, promoting equity and social justice in education.

Involving the community and incorporating local language stand out as powerful strategies to bridge the gap between formal mathematics and indigenous knowledge systems. These approaches empower students, break down language barriers, and deepen their understanding of mathematical concepts.

Together, these findings advocate for a transformative shift in mathematics education, one that embraces and celebrates the cultural diversity of its learners, ultimately fostering a more inclusive, meaningful, and pertinent educational experience for all.

Recommendations

Based on the research gaps identified in this study, the study recommends the following:

Policy Reforms: Governments and educational authorities should prioritize and implement policies that explicitly support the integration of Indigenous knowledge, local languages, and cultural perspectives into the mathematics curriculum. These policies should reflect a commitment to inclusivity and cultural diversity.

Curriculum Development: Curriculum designers and educators should work collaboratively to develop math curricula that incorporate Indigenous games and cultural perspectives, making mathematics more relevant and engaging for students. These curricula should connect abstract mathematical concepts to real-world applications within local contexts.

Community Involvement: Engage local communities in the development and implementation of culturally relevant mathematics education. Communities can provide valuable insights into how mathematics relates to their daily lives and can help bridge the gap between classroom learning and practical applications.

Teacher Training: Offer specialized teacher training programs that equip educators with the skills and knowledge needed to effectively integrate Indigenous games, local languages, and cultural perspectives into their teaching practices. This training should focus on culturally responsive teaching methods and strategies.

Resource Allocation: Allocate resources, including funding and teaching materials, to support the integration of Indigenous games and cultural perspectives into mathematics education. This may involve creating or adapting teaching materials that reflect local cultures and languages.

Monitoring and Evaluation: Implement a system for monitoring and evaluating the effectiveness of these innovative approaches in mathematics education. Regular assessments and feedback from students, teachers, and communities can help refine and improve the implementation of these practices.

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